PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : H04N 7/173, 7/15

A1

(11) International Publication Number: WO 94/23537

(43) International Publication Date: 13 October 1994 (13.10.94)

(21) International Application Number: PCT/US94/03629

(22) International Filing Date: 31 March 1994 (31.03.94)

(30) Priority Data:
08/042,107 1 April 1993 (01.04.93) US

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(81) Designated States: AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, ES, FI, GB, GE, HU, JP, KP, KR, KZ, LK, LU, LV, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SI, SK, TT, UA, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published

With international search report.

Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: METHOD AND SYSTEM FOR ACCESSING MULTIMEDIA DATA OVER PUBLIC SWITCHED TELEPHONE NETWORK

(57) Abstract

A public switched telephone network for providing information from a multimedia information server to any one of a plurality of subscriber premises, comprises a central office receiving multimedia information signals from a multimedia information server and orders from a prescribed subscriber. The central office includes a gateway system for conveying routing data in response to subscriber orders and a switch for routing multimedia signals from the server to the prescribed subscriber in accordance with the routing data. An interface at the central office transmits and receives audio telephone service signals, subscriber control signals and digital multimedia information signals on first, second and third signal channels. Each subscriber premises includes an interface for transmitting and receiving audio telephone service signals, subscriber control signals and digital multimedia information signals on the three signal channels. A plurality of subscriber local loops interconnect each subscriber interface and the central office interface. Multimedia information is collected from information providers and stored at media servers that provide a library of data and control sessions. Software modules at the media servers and resident terminals enable interactive multimedia session building, sharing of databases and joint authoring of multimedia presentations.

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METHOD AND SYSTEM FOR ACCESSING MULTIMEDIA DATA OVER PUBLIC SWITCHED TELEPHONE NETWORK

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of copending application serial number 07/766,535 filed September 27, 1991, assigned to the assignee of the present invention.

TECHNICAL FIELD

The invention relates to data distribution using the Public Switched Telephone Network (PSTN), and, more particularly, to distribution of multimedia data to subscribers over a PSTN.

BACKGROUND ART

Advances in personal computer capabilities have created increased demands on data base sources to supply information to households and business. Corresponding increases in data availability, storage, retrieval and transmission capabilities have supported multimedia data presentation of information. Multimedia presentations include, in addition to conventional text, still-images, animation, slow and fast scan video, and graphics format visual presentations. Multimedia also includes sound data presented together with, or independent of, one or more

visual presentations. A multimedia presentation can range from the equivalent of an electronic book including plain text in combination with still images to full motion video presentations of feature movies. Thus, multimedia spans a wide spectrum of data storage, retrieval and transmission requirements to present information in various formats to system subscribers.

Considerable potential exists to improve the availability of multimedia service to the public. One example is in education. Several segments of society find themselves remote from learning resources. Educators have traditionally tried to find a way to overcome the limitations imposed by physical distance, on one hand by using school buses to transport people and on the other by employing telecommunications to transport information. However, physical distance remains a barrier to education despite numerous experiments and studies to solve the problem. Known proposals to implement multimedia information transmission over the public service telephone network have not yet been successful, in part by the limited bandwidth of telephone cable and the unavailability of adequate technology to support copper based multimedia information transmission. Broad bandwidth transport is necessitated not only by the need to carry good quality video information from an information provider to the student, but subscriber control signals and ordinary telephone service as well.

Although optical fiber is capable of providing sufficient bandwidth, even optimistic projections of installation of fiber in the local loop expect only modest market penetration by the turn of the century and ubiquity many years after that. This invention implements the public switch telephone network (PSTN) to carry out transport of multimedia information from one source or multiple sources to a subscriber over a single loop in the

form of copper wire or other medium, including fiber, to help remove distance as a barrier to information transfer at affordable cost.

DISCLOSURE OF THE INVENTION

According to one aspect of the invention, a public switched telephone network for providing information from a multimedia information server to any one of a plurality of subscriber premises comprises a telephone company central office receiving multimedia information signals from a multimedia information server and orders from a prescribed subscriber. The central office includes a gateway system for providing routing data in response to subscriber orders and a switch for routing multimedia signals from the server to the prescribed subscriber in accordance with the routing data. An interface at the central office includes a first frequency multiplexer/demultiplexer for transmitting or receiving audio telephone service signals, subscriber control signals and digital multimedia information signals on first, second and third signal channels displaced from each other in frequency. Each subscriber premises includes an interface having a second frequency multiplexer/demultiplexer for transmitting or receiving audio telephone service signals, subscriber control signals and digital multimedia information signals on the three signal channels. A plurality of subscriber local loops interconnect each subscriber interface and the central office interface. Preferably, the central office interface comprises a plurality of interfaces, one for each subscriber.

In accordance with the preferred embodiment, the first channel is a bidirectional channel carrying audio telephone service signals between the subscriber and

central office. The second channel is a unidirectional channel carrying subscriber control signals to the central office, and the third channel is a unidirectional channel carrying digital multimedia information signals from the central office to the subscriber. The local loops preferably comprise copper pair wiring, although optical fiber is another possibility.

Furthermore, the subscriber interface preferably includes a decoder for converting an incoming digital multimedia information signal to an analog signal having a video component. The decoder decompresses the incoming multimedia signal and produces analog video and associated audio output signals.

In accordance with a particular aspect of the invention, the central office further includes a packet data network responsive to the gateway system for supplying command signals to the multimedia information server. Digital multimedia information storage, remote from the subscriber premises, buffers multimedia information obtained from the switch and supplies buffered multimedia information to the central office interface.

In the preferred embodiment of the invention, the multimedia information server comprises a subscriber request processing means, responsive to subscriber request data, for supplying information request data and a session control means, responsive to the information request data, for supplying information retrieval data and output control data. Also included in the server are a data storage means, preferably comprising plural types of storage media, responsive to the information retrieval data for supplying program data and an output control means, responsive to the output control data, forsupplying the multimedia information.

Another aspect of the invention involves interaction between subscribers and sources of multimedia information.

In accordance with the preferred embodiment, the multimedia server system comprises a number of data bases that are transparently shared by a subscriber. When the subscriber queries a principal data base containing multimedia information and does not find the information sought, other data bases sharing resources either through the gateway system or outside the gateway, are searched.

A further aspect involves multiple subscriber interaction with the multimedia servers. Groupware functionality incorporated in subscriber resident software enables subscribers to share a session and thereby mutually contribute to a multimedia joint presentation.

Various objects and advantages of the present invention will become readily apparent to those skilled in this art from the following detailed description, wherein only the preferred embodiment of the invention is shown and described, simply by way of illustration of the best mode contemplated of carrying out the invention. As will be realized, the invention is capable of other and different embodiments, and its several details are capable of modifications in various obvious respects, all without departing from the invention. Accordingly, the drawing and description are to be regarded as illustrative in nature, and not as restrictive.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a system diagram of a PSTN incorporating flow of multimedia information from a source to a subscriber, in accordance with the invention.

Figure 2 is a simplified block diagram of a media server, according to the invention.

Figure 3 is a more detailed block diagram of the media server of Figure 2.

Figure 4 is a block diagram of program storage

facilities of the media server.

Figure 5 is a functional diagram of a subscriber interface unit.

Figure 6 is a spectrum diagram showing channelization of a local loop by the interface unit.

Figure 7 shows a typical in-the-home configuration providing video transported over a 1.544 MBPS channel overlaid with standard telephone service signaling.

Figure 8 is a block diagram of the interface unit in the form of an asymmetrical digital subscriber line (ADSL) system providing simplex high-bit-rate access and POTS on a common copper loop.

Figure 9 is a diagram of the ADSL multiplexer at the subscriber's premises.

Figure 10 is a diagram of decoder unit at the subscriber's premises.

Figure 11 is a diagram depicting interaction among server, data base and subscriber software modules, in accordance with the invention.

Figure 12 shows the architecture of software for performing communications between subscribers sharing in a multimedia session and the central office.

BEST MODE FOR CARRYING OUT THE INVENTION

Overview

The digital multimedia information service platform shown in Figure 1 is of an architecture similar to the type described in copending application serial number 07/766,535, filed on Sept. 27, 1991 and entitled PSTN ARCHITECTURE FOR VIDEO-ON-DEMAND SERVICES, modified to accommodate delivery of multimedia services to subscribersthat include home subscribers, at exemplary terminal 120, and institutions such as schools as at terminal 100. The architecture for multimedia delivery,

in accordance with the invention, includes four main components: at least one multimedia server (two servers 200, 202, are shown in this example) a gateway system 30, a transmission system and the subscriber terminals. The multimedia servers store compressed multimedia presentations in the form of data files received from providers of multimedia information 140, 160. The information providers 140, 160 transmit coded digital multimedia data over wideband PSTN supplied connectivity to the central office (CO). The data may be buffered at the central office for transmission over a POTS line to the subscriber.

The gateway system 30 performs two main functions. It controls access to the multimedia servers 200, 202 and sets up a high speed link between the servers and subscriber terminals via the transmission system.
The multimedia file server system 200, 202 handles requests received from the gateway system 30 and provides a video file feed to the subscriber via the network link. The server is a file management system responsible for inputting video files from providers, storing these files or passing the real-time data through to the subscriber, keeping track of sessions, handling all interactive control requests from the subscriber, and controlling all outputs.

The transmission system uses a transmission medium of optical fiber or of telephone cable carrying separate channels of audio telephone service, single direction subscriber control signals and multimedia signals, multiplexed/demultiplexed at central office and subscriber interfaces. Alternatively, a public switched telephone network coupled with a Public Data Network (PDN) or an Integrated Services Digital Network (ISDN) can beused. Data can be packetized in the PDN and transmitted to the gateway system 30. When ISDN is used, the data are

packetized in the subscriber terminal itself, which preferably is in the form of a personal computer.

Utilizing a communications application program in the terminal, the subscriber sets up a connection to the gateway system 30. The gateway 30 validates the subscriber through a log-in sequence and presents a menu of available multimedia presentations from which the subscriber can choose. When a choice has been made, the gateway system 30 provides the multimedia server with the selection information and the network address of the subscriber. The multimedia server sets up a connection to the subscriber. When the connection has been established, the subscriber may interact with the multimedia presentation by sending commands to the multimedia server and receiving responses at the terminal. The server may, if necessary, access information from another multimedia server to satisfy a particular request for information.

The multimedia presentation can be full motion video, text, graphics, animation, audio information, etc. Alternatively, the complete multimedia presentation may be transferred to the subscriber terminal where it will be stored locally in a high capacity storage device. All interactions between the subscriber and the multimedia presentation will then occur locally at the subscriber terminal. Through use of resource sharing programming, subscribers can share a session, jointly accessing the server and authoring a multimedia presentation, a capability particularly useful to students.

The platform adopts existing components of the Public Switched Telephone Network (PSTN) and implements compression techniques to store video information for subsequent forwarding over interoffice facilities. The switching facilities are located in central officesserving residential subscribers. Loop electronic devices modify the transmission characteristics of the local copper loop

to provide required enhancement to the PSTN and permit delivery of full multimedia information.

High data rate types of multimedia data are encoded to conserve system resources. For example, analog video information is first converted to a digital format using encoding algorithms standardized by the International Standards Organization (ISOs) Motion Picture Experts Group (MPEG). Each title comprises information stored by a media server as an addressable data file in conventional data processing devices functioning as a video library. Establishing and monitoring connections linking a library port transmitting selected information with the end subscriber ports receiving the information are performed by a supervisory controller such as a network control system, e.g., FLEXCOM (TM) software, used to control an electronic digital cross-connect switch system (DCS) 24 in the PSTN. The DCS 24, also used for switching two-way DS-1 rate transmissions, is adapted to additionally provide bridging or broadcast of video information to several subscribers.

Subscriber local loops having ends equipped with asymmetric digital subscriber line (ADSL) devices 18, 124 are connected to the DCS 24. The multimedia distribution system provides for the simultaneous transport of a one-way 1.544 megabit per second (MBPS) signal over the same twisted pair transmitting voice messages to the residential subscriber. The ADSL transported signal is demultiplexed and the 1.544 portion is then decoded using MPEG standard techniques to deliver a full motion video signal.

It can be anticipated that fiberoptic technology will replace existing coaxial and twisted pair connectivity with corresponding enhancements made toswitching and routing equipment in the PSTN. Hence, with reference to Figure 1, assume the subscriber is a

school or other site having multiple student terminals, as at institutional site 100. Connectivity from the multimedia server on optical fiber is multiplexed to student terminals on separate DS1 channels. Each student will communicate with the server through a personal computer to develop a multimedia presentation. As will be described later, in accordance with an aspect of the invention students are enabled to share a common session with the server, or with multiple servers.

PSTN Architecture

Referring now to Figure 1 in more detail, the multimedia system, configured in accordance with the invention, includes PSTN central office (CO) equipment 10 providing connectivity from information providers 140 and 160 through the system to media servers 200, 202 and subscribers 100 and 120. CO 10, which may but not necessary is telephone company central office equipment, includes a conventional voice switch 12 that includes conventional elements to detect off-hook, service requests, call completion (i.e., ring trip), a DTMF decoder 14 and dial pulse detector. Voice switch 12 also includes a telephone call connection switch for routing voice circuits among the various ports.

The institutional subscriber at location 100 is connected to media server system 200, 202 through fiber optic cable 22. Multiple terminals on DS1 lines are multiplexed to the cable 22 by a standard multiplexer device 25. A residential subscriber at premises 120 is connected to the CO 20 through an interface consisting of an asymmetrical digit subscriber line (ADSL) system. The ADSL system comprises a pair of ADSL devices 124 and 18 on the subscriber and CO ends of the subscriber loop 20 formultiplexing (i) voice and signaling information from voice switch 12 and (ii) digital multimedia data from DCS

24. Multimedia data from multimedia information providers 140 and 160 are provided to DCS node 26 where it is supplied to the media server system 200, 202 or immediately transmitted to DCS node 24 under control of network management system 28. Although no ADSL devices are arranged on the line 22 to institutional subscriber 100, it is possible to incorporate ADSL devices in that service to establish channel multiplexing.

In addition to providing multimedia programming, the server system 200, 202 accepts multimedia programming from multimedia information providers 140 and 160 for later transmission and for real-time and multi-pass encoding. Real-time encoding is used to provide encoded high bandwidth signals such as full motion video while minimizing network transmission requirements and providing a signal compatible with ADSL connectivity to subscriber premises 120. Multi-pass encoding performed by the media server provides a higher quality video signal for storage and later transmission over the network to subscriber premises 120.

ADSL system 18, 124 multiplexes data on subscriber loop 20 using frequency domain multiplexing, dividing the available loop bandwidth into multiple segments or channels. Base band audio and signaling below 4 kilohertz (kHz) provides connectivity for a conventional telephone services available on the "plain old telephone system" (POTS). Alternatively, ISDN channel requirements consume the bottom 80 kHz of loop bandwidth. Reverse channel digital packet information is positioned between 80 and 90 kHz providing approximately 16 kilobits per second (kbps) connectivity from the subscriber premises to a packet switched network such as ISDN network over a D-channel interface. Compressed multimedia data is containedbetween 100 and 400 kHz to provide a 1.6 MBPS channel for transporting the multimedia data over respective loops 20

and 22 to customer premises 120.

ADSL 18 carries out error correction and, as shown in Figure 6, divides the available loop bandwidth into three channels 302, 304 and 306. Base band audio and signaling below 4 kilohertz (kHz) provide connectivity for a conventional telephone services available on the "plain old telephone system" (POTS). Alternatively, ISDN channel requirements consume the bottom 80 kHz of loop bandwidth. Reverse channel digital packet information, centered on 95 kHz., provides 8 kilobits per second (kbps) of handshaking protocol between the subscriber- and CO-side ADSLs 124 and 18 to test the copper pair transmission path, and approximately 16 kbps connectivity from the subscriber premisses to a packet switched network, such as the ISDN network over a D-channel interface. The 16 kbps signal is stripped by the ADSL 18 and sent to the CO 10. Compressed digital video information is contained within the frequency range of about 100 and 500 kHz to provide about a 1.6 mbps (1.544 mbps) channel for transporting video/audio data over loop 20 to subscriber premises 120.

The frequency channel represented by segment 302 in Figure 6 thus establishes a 2-way channel used to provide standard POTS service or ISDN (2B+D) service over the subscriber loop 20. Channel 304 is an up-stream only (subscriber to CO), low speed data channel. Eight kbps of this channel is used for transfer of operations, administration, maintenance, and provisioning (OAM&P) data for the ADSL unit. The remaining 16 kbps, compatible with X.25 or D channel interfaces of BRI-ISDN, is used to interface with a packet switch allowing the subscriber to interact with the network and/or the 1.544 mbps signal provider.

Channel 306 carries a down-stream only (CO tosubscriber) digital signal providing 1.544 mbps transport (1.6 mbps with overhead) for carrying the

digitized compressed video signal. The lower edge of channel 306 is set at 120kHz., chosen to minimize channel loss and allow appropriate bandwidth for base band channel 302 and reverse channel 304 and to minimize interference from impulse noise. The combined digital down-stream signal utilizes the DS1 bit map specified by ANSIT1.403-1989.

Because data channels 304 and 306 are unidirectional, the system does not experience self-NEXT (near end cross-talk). This allows concentration on the interface and interference from impulse noise because the ADSL system is loss-limited rather than NEXT limited. Impulse noise exposure can be reduced by using a pass band technique as opposed to a base band approach since impulse noise affects are greatest below 40kHz. Therefore, a modulation technique such as Quadrature Amplitude Modulation (QAM) is preferred over a 2B1Q base band system.

ADSL multiplexer 200 shown functionally in Figure 5, in combination with ADSL line 202, supports transmission of a one-way 1.544 mbps digital signal along with a POTS or a BRI-ISDN signal over a single non-loaded copper pair. This configuration provides service to a customer over copper loop lengths of up to 18,000 feet, conforming with Carrier Serving Area (CSA) and resistance design rules. Discreet multi-tone is an alternative.

The ADSL system (the hardware block diagram is shown in Figure 8) provides simplex high-bit-rate video data and POTS connectivity to a subscriber over a common copper loop with transport capability to deliver a one-way high-bit-rate data stream with POTS or ISDN basic access multiplexed at baseband. Each ADSL on the subscriber- and CO- sides includes an error correction circuit 21 implementing an error correction algorithm, such as the Reed-Sullivan algorithm, for correcting errors that ariseas a result of transmission of data on a twisted pair

of copper lines. The subscriber- and CO-side ADSLs on opposite ends of the twisted copper pair carry out "handshaking" while implementing the algorithm to reduce error in the video signal to a minimum.

Referring to Figure 9, the multiplexer 200 residing in each subscriber-side ADSL includes, in addition to a frequency converter 420 for channelizing the incoming signal into 1.544 Mbps, 16 Kbs and 8 Kbps components, a splitter/filter 400 for separating the standard POTS signal from the video composite. Hence, the video component incoming on the twisted copper pair is transparent to a standard phone resident on the line at the usual network interface device (NID).

Subscriber and CO ADSL interface units 134 and 10 are synchronized to ensure that both subscriber and CO side units derive timing from one master clock to prevent data loss. Preferably, the units derive timing from the incoming 1.544 mbps signal. Subscriber end ADSL equipment is powered locally from the customer premises; CO end ADSL equipment is preferably powered by an external source of DC input voltage in the range of between -42.5 and -55 VDC.

Figure 7 shows a typical in-the-home configuration which provides video transported over the 1.544 mbps channel. The unidirectional 1.544 mbps signal carried by the ADSL system has either a Superframe Format (SF) or an Extended Superframe format (ESF). The Superframe format consists of 24 consecutive 8-bit words preceded by one bit, called the framing bit (F-bit), for a total of 193 bits per frame. The F-bit is time-shared to synchronize the ADSL interface equipment and to identify signaling framing. Twelve consecutive frames form a Superframe. A line code used with a Superframe format is bi-polar return-to-zero, also known as Alternate Mark Inversion(AMI).

The ESF format consists of 24 consecutive frames, each of which includes 192 information bits preceded by 1F-bit for a total of 193 bits per frame. The F-bit is used for basic frame synchronization, a cyclic redundancy check and a data link. Twenty-four frames form a Superframe. The line code used with the ESF is either AMI, bi-polar 8-zero substitution (B8ZS), or AMI with Zero-Byte Time Slot Interchange (ZBTSI).

Although Figure 7 depicts the splitter/filter 400 and converter 420 in the form of separate units, the two can be combined with a converter as a single unit residing outside the ADSL enclosure. Alternatively, the converter 420 and decoder 126 can occupy a common enclosure, and the splitter/filter 400 arranged as part of the NID at the subscriber's premisses.

The MPEG decoder 126 of Figure 7, shown in more detail in Figure 10, includes a T1 input 450 for high speed data, preferably at 1.544 mbps and of DS1 format, and an input 452 for a control signal of frequency of up to 16 kbps. The control signal is applied to known MPEG control processing circuitry 462. The video signal applied to input 450 is decoded by video decoder 454 to produce an NTSC base band signal to be supplied to an output port, as shown, such as an RCA jack. The output signal in turn is applied to the video terminals of a television, preferably within a frequency band corresponding to program channel 3 or 4.

The audio component derived from the video signal using conventional signal manipulation is applied to audio processing circuit 452 to attain right and left channel audio components represented by block 460 for supply to a stereo amplifier (not shown). Alternatively, the audio and video components can remain synchronized and be supplied to the television through a conventional RFmodulator (not shown). Although not shown in Figure 10,

the front of the enclosure housing the MPEG encoder preferably has an interface for accommodating an infrared remote control unit.

Media Server System

The media server system 200, 202, shown in further detail in Figures 2-4. processes all requests from gateway system 30 for providing multimedia and video file feeds to customer premises via the DCS and ADSL systems. The media server system preforms input of video and other information files from multimedia information providers 140 and 160, stores these files or passes real-time data through to subscriber 120, monitors and records subscriber sessions, processes all interactive control requests from subscribers, and controls all outputs to the subscribers.

The media server system 200, 202 also processes and supplies multimedia services including interactive learning, interactive games, and other presentations. The server stores and processes all data required for the multimedia applications including text, still pictures, audio, and partial and full motion video, as well as interactive application scripts.

Media server system 200, 202 includes eight major components shown in Figure 2: input device 210, Q.931 interface 230, librarian 250, storage manager 270, session manager 320, output controller 310, interactive processor 350 and multimedia application processor 370. Input device 210 includes a plurality of DS-3 Input ports 212 for receiving multimedia data including digitized video in the form of MPEG encoded digital video signals of D1 digital video. D-1 digital video is supplied to librarian 250 for MPEG encoding. Video supplied in MPEG encoded format is supplied to output controller 330 or to gateway interface 410 to be routed to session manager 310 foreventual storage by the server system.

The network control software of the media server in combination with management resources of the PSTN controls the "network session" between an output controller 310 of the media server, external program providers, and subscriber ports. The session manager 310 also maintains a record of relevant data regarding each session which is forwarded to a customer billing system.

Q.931 interface 230 provides connectivity between interactive processor 350 and ISDN D Channel Interface 38 (Figure 1). Interactive processor 350 receives command data over the ISDN from subscribers running interactive programming from the media server. Interactive programs include multimedia presentations and video games. The interactive processor also receives command data from subscriber control unit 130 for interactive control of feature presentations including pause, fast-forward, reverse, and other "VCR" type capabilities supported by the media server. These latter commands are passed to session manager 310 for further processing and control of the video programming.

Data to be stored or retrieved from memory is first routed through librarian 250 and, under its control, storage manager 270 either stores the program data or retrieves and provides previously stored program data to output processor 330.

Media librarian 250 controls distribution of video, audio, still image data and text selections to session manager 290 in response to information requests from the session manager and multimedia application processor 370. Referring to Figure 3, the librarian further monitors and record in feature index 252 the storage location of all video selections for multimedia applications. The librarian also records a history of access to video programming, i.e., "features" and to other data providedduring each twenty-four hour period in usage data

accumulation system 260. The usage data is supplied to usage probability processor 262 to establish an intelligent cache using DRAM storage 278 for rapid access and highly addressable storage of features.

Feature indexes 252 maintain a catalog of data and support processing for storing all locally stored programs. This includes the allocation of storage media type and space, maintenance of addressing tables for program stat and frame indices, and indexes for all volumes. The program listing data is supplied to a menuing system supported by gateway 30 (Fig. 1) via packet data network 40.

Feature indexes system 252 performs required catalog maintenance functions including input of new feature program data into the system, ageing, and deletion or archival of aged program data. New program data from multimedia information providers to be stored by the media server are received via a DS-3 port 212 of input processor 210. The catalog maintenance system determines the priority of the incoming program data and allocates appropriate storage to the data. Once the file space is allocated and the file is stored, the volume indexes are updates, the frame positions of the program are calculated and frame addressing tables are created and stored. The frame addressing tables are used to address a feature from any position in the feature.

When is determined that stored feature is no longer required, media librarian 250 removes the program data from the file catalog. The record to be deleted is then flagged by the system administrator.

Librarian 250 tracks frequency of feature access. As information is requested less frequently, it is "aged" by the media server. Usage probability processor 262 assigns a priority value to the information which is used todetermine the appropriate storage type to maximize

system resources while providing acceptable access time to the feature based on its demand history. Once information is aged to a point of not having been requested for a predetermined time period, the media server removes the program from on-line storage units 278, 282 and 286 and places it in archival storage 290. The feature header data remains stored in feature indexes 252, although access time for the feature will be increased.

The catalog system updates feature titles data as the features ate loaded into the media server. The updated catalog information is supplied by librarian 250 of the media server to gateway 38. The data supplied to the gateway 38 is shown in Table 1.

TABLE 1

ELEMENT	USE	ORIGIN	TYPE
Feature Title	To be used by the menu system to update the list of features provided for the users	Video information provider or programmer	
Feature Index Number	Used by the gateway when transmitting a request to the server	Librarian	Alpha/Numeric
Priority	Used by the gateway to determine the set-up and wait time for a feature	Originally determined by the feature box office ranking. Subsequently determined by the Trend processor.	Integer
Feature Length	Used for schedule processing by the gateway	VIP/Programmer	
Key Actor/Actress, Author, Director, Subject	Used by the gateway for performing searches on the elements listed	VIP	Array
Motion Picture Association Rating	Used by the gateway for feature type blocking based on rating G, PG, PG-13, R, NC-17, XXX	VIP	
Category	Used by the gateway menu processor to determine the placement of the title	VIP	

Usage probability processor 262 statistically determines features having the highest probability of usage on a per hour, day of week basis to properly allocate high order storage, i.e., DRAM storage 278, on an hourly basis. In support of this function, usage data accumulation 260 stores tables of data including time of viewing, day of viewing and cumulative number of requests each time a feature is supplied.

Allocation of storage in the media server is based on the ranking of a feature and the output of the trend processing performed by usage probability processor 262. Storage is divided into several components, including DRAM 278, magnetic disk 282, high speed magnetic tape 286 and archival magnetic tape 290. All features are stored on the appropriate media based on the priority ranking of the feature. For example, DRAM storage 278 is used for the highest priority features as determined by the trend processing whereas archival storage is used for the lowest priority features. Table 2 gives typical priority assignments and storage capabilities of each medium.

TABLE 2

PRIORITY	NUMBER OF FEATURES	STORAGE
1	20 ± 5	DRAM
2	100 ± 20	MAGNETIC DISK
3	300 ± 50	HIGH SPEED TAPE
4	500 +	ARCHIVAL TAPE

DRAM storage 278 is used for the highest twenty features and data files as determined by the trend processing. When a feature or other high priority media file is stored in DRAM it does not occupy magnetic storage space until removed from DRAM storage.

Disk storage units 282 are fast access magnetic and/or optical media providing storage for the second

highest fifty priority media data files as determined by the trend processing. When a feature is stored on a disk unit, it does not occupy DRAM or tape storage until removed.

High speed tape storage units 286 store features and media data files having a medium priority as determined by the trend processing. Finally, archival tape storage is used for the lowest priority of features and media data files.

Storage channel management processor 274 controls the flow of data between all storage devices and output control processor 330. Input control processor 210 receives multimedia data from multimedia information providers 142 and 162. Feature data input streams are accepted either as MPEG encoded digital video or as D-1 digital video for encoded by the media server. All data is either stored for play at a subscriber's request or passed directly through to the subscriber as real-time programming.

MPEG encoded video data received at DS-3 port 212 of input processor 210 is routed to session supervisor 312 for storage by the media server or as flow through to an appropriate output port 332 of output processor 330. Session manager 310 supervises the data flow once connection from the multimedia information provider to the subscriber is established by input control processor 210 and output processor 330. No data is stored and no index information is supplied to librarian 250.

For non-encoded data, a simplified form of MPEG encoding is performed by real-time MPEG encoder 390, requiring a latency of approximately ten minutes from data input to data output. Multi-pass MPEG encoder 392 is used for non-real-time processing, and provides full MPEG encoding of video data. Both MPEG encoders receive non-encoded video data from input processor 210 and provide

encoded video to storage allocation processor 272 of storage manager 270. The encoded video data is either stored in an appropriate storage media or transmitted by storage channel management controller 276 to output controller 310 for transmission to a subscriber over the PSTN.

Session manger 310 include session supervisor 312 which manages all program sessions including system access by multimedia subscribers and input and output to, from and through the media server by multimedia information providers. Session supervisor 312 tracks and records all data considered pertinent to a subscribers session including output port, input port (if receiving data directly from a multimedia information provider or if the user is a multimedia information provider), feature being played or multimedia application address, feature index data, feature frame data, and sessions condition. The session supervisor also performs network resource optimization by the simultaneous broadcast of the same feature over one output port to multiple subscribers. However, each subscriber session is individually managed to permit interactive features such as video pause.

Session trace processor 314 tracks each subscriber's session base on feature and frame so that the execution of a pause sequence can be managed for each individual session. A subscriber may start viewing a feature as one subscriber as part of a larger group, selection of a pause function places the subscriber "out of sync" with the rest of the group requiring establishment of a separate session for that subscriber and requiring session manager 310 to cause the gateway to establish a new network link to the subscribers viewing location. Although each subscriber is assigned an individual logical session, sessions in sync with one another can share output and network facilities.

Session supervisor 312 maintains a matrix of routing

information for each session, including what subscribers are assigned to a given output port, and the source of the input data, that is, the input Port of local storage. A file play clock uses the total number of frames in a given feature to estimate, by time, the frame position for that feature. This data is provided to the session registers for tracking frames for each logical subscriber session and is used to restart an interrupted session. Session supervisor 312 discontinues register updates upon detection of a session interruption.

The session supervisor also receives all requests from gateway 30 via Q.931 interface 230 and control channel filter 354 to establish a session and for file retrieval.

Interactive processor 350 processes incoming commands from subscriber sites once a session is established by the gateway. These commands include requests by multimedia work stations. The incoming data is interrogated for content and selectively forwarded to the appropriate module for processing, that is, the multimedia application processor for multimedia applications.

Control channel monitor 352 monitors each subscriber's control channel to detect a communication failure. In the event of a failure, session manager 310 is informed and corrective action is initiated.

Communications Software

Figure 11 shows the software architecture for setting up communications between the subscriber terminals and the gateway, in accordance with the preferred embodiment. There are two principal programming modules: a server resident module 500 and a subscriber module 502 resident at customer premises equipment, interconnected with each other through DS-1 and/or ISDN channels. Within the server resident program module 500 is a resident database

for storing multimedia information derived from the media server, an interface to the gateway system 30 and control software for controlling playback of session information at the terminal. An additional general utility communication program enables dialogue to be carried out between the subscriber and server, or between subscribers cooperating in a session.

The CPE resident software contains counterpart database, control (playback) and gateway interface software. The CPE control software will respond to subscriber commands, such as the commands generated by the position of a mouse, to send a command signal to the server. The server, in turn, will interpret the command signal and transmit appropriate multimedia information on the DS-1 or ISDN channel to the subscriber. In this regard, the server reads the command signal, customizes or interprets it in view of the session being conducted, and makes a decision as to what next piece of multimedia information should be presented. The resident software loads the segments of information to be sent to the subscriber into a buffer, notifies the subscriber software that the next screen is ready to be downloaded, and the multimedia information sent. The purpose of the buffer is to enable construction of a seamless multimedia session composed of multiple data files that are assembled in sequence.

Through interactive communication with the server, the subscriber is able to redirect the multimedia session at each logical branch. The subscriber supplies the various control signals to create a multimedia performance to the authoring software module that recreates a new copy of a series of old multimedia information elements. The resulting copy is saved at the server and may be accessible to other subscribers, with certain constraints, under control of a system administrator.

Alternatively, a multimedia presentation may be comprised of multiple multimedia elements that are stored in a number of buffers within the server and indexed by a script stored at the subscriber terminal playback module for each presentation. The buffer size at the server memory is dependent on the amount of time required to access the data base and retrieve the elements, and to process the elements for delivery to the subscriber. Decision alternatives available to the subscriber during an interactive session are sent by the server to the playback unit of the subscriber. The playback module in the resident software thus includes the script itself and portions of the script. For each decision point, queuing information is provided to the server so that the server can ready other presentations while the selection of the next presentation is still carried out at the subscriber terminal. For example, four selections may be queued to the subscriber, and the playback module is controlling a particular one to play out.

If the media server is found not to contain a particular piece of information sought by the subscriber, the gateway system 30 is notified by the server, and other databases may be automatically searched for the required information. These databases may be resident at different media servers, such as servers 200, 202.

Alternatively, the subscriber may be notified of the failure of the media server database to satisfy the current information request and the subscriber given an option to search other data bases within a single media server, at another server of the media server system or outside the server system. As another alternative, other databases, broadband channeled to the media server outside the gateway system, may be searched. Intercommunication between data bases may be performed on a switched DS-3 line implementing a broadband gateway system, as shown in

Figure 11, or within an asynchronous transfer mode (ATM) environment.

Although a multimedia session ordinarily will involve one subscriber at a time, it is possible to enable multiple subscriber terminals to share a session using known "groupware" software at the subscriber terminals, as shown in Figure 12, or communication software such as Rainbow (TM) or PCAnywhere(TM). Alternatively, the subscribers may coauthor a multimedia presentation using two B-channels of ISDN, a separate ISDN line using a second ISDN communication board or E-mail communication between subscribers operating a common session. This enables students to jointly author a multimedia presentation, and other forms of teaming efforts to be carried out.

As still another possibility, video communications may be established between server and subscriber terminals or between subscribers. For example, subject to federal regulations, a video camera may be provided at one subscriber terminal at a classroom, and video signals sent to a second terminal where an instructor resides to enable an instructor to view students during an interactive session.

The server resident software monitors the amount of time a subscriber is on line, and together with the gateway system, performs billing operations. If the subscriber remains on line for more than a prescribed amount of time without sending any command signals to the server, the server automatically drops the line, and is free to service other subscribers. However, when the subscriber next sends a command signal, the link between the server and subscriber is automatically reestablished.

Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustration an example and is not to be

taken by way of limitation, the spirit and scope of the present invention being limited only by terms of the appended claims. As one example, although the network, as described, implements an ISDN interface 38, as shown in Figure 1, an X.25 interface is an alternative.

WHAT IS CLAIMED IS

1. A public switched telephone network for providing information from a multimedia information server to any one of a plurality of subscriber premises, comprising:

a telephone company central office receiving multimedia information signals from a multimedia information server and subscriber orders from a prescribed subscriber, said central office including a video gateway for providing routing data in response to subscriber orders and a switch for routing multimedia signals from said server to the prescribed subscriber in accordance with said routing data;

a central office interface including a first frequency multiplexer/ demultiplexer for transmitting or receiving audio telephone service signals, subscriber control signals and digital multimedia information signals on, respectively, first, second and third signal channels displaced from each other in frequency;

each said subscriber premises including a second frequency multiplexer/demultiplexer for transmitting or receiving audio telephone service signals, subscriber control signals and digital multimedia information signals on, respectively, the first, second and third signal channels; and

a plurality of subscriber local loops interconnecting corresponding a corresponding subscriber interface and said central office interface.

2. The network of claim 1, wherein central office includes a plurality of interfaces, one for each subscriber.

3. The network of claim 1, wherein said first

channel is a bidirectional channel carrying said audio telephone service signals between the subscriber and central office, said second channel is a unidirectional channel carrying subscriber control signals to said central office, and said third channel is a unidirectional channel carrying digital multimedia information signals from said central office to the subscriber.

4. The network of claim 1, wherein said subscriber interface includes a splitter for supplying telephone service and multimedia information signals incoming from the central office to telephone and television terminals.

5. The network of claim 1, wherein said local loops comprise coaxial cable.

6. The network of claim 1, wherein said local loops comprise optical fibers.

7. The network of claim 1, wherein said subscriber interface includes a decoder for converting an incoming digital multimedia information signal to an analog signal having a video component.

8. The network of claim 7, wherein said decoder includes a decompressor for decompressing the incoming video signal and producing analog video and associated audio output signals.

9. The network of claim 1, wherein said central office further includes a packet data network responsive to said video gateway for supplying command signals to said multimedia information server.

10. The network of claim 1, including digital

information storage means remote from the subscriber premises for buffering multimedia information obtained from said switch and supplying buffered multimedia information to the central office interface.

11. The network of claim 1, wherein said multimedia information server comprises:

subscriber request processing means responsive to subscriber request data for supplying information request data;

session control means responsive to said information request data for supplying information retrieval data and output control data;

data storage means responsive to said information retrieval data for supplying program data; and

output control means responsive to said output control data for supplying said multimedia information.

12. The network of claim 11, wherein said data storage means includes a plurality of storage media for storing said program data.

13. The media server according to claim 12, wherein said data storage means includes optical storage means and magnetic storage means.

14. The media server according to claim 14, wherein said data storage means includes different storage media having different respective information retrieval times.

15. A central office based public switched telephone network for supplying digital multimedia information from a digital information storage medium to designated subscriber premises, comprising:

subscriber loop transmission means for transferring

(1) selected digital multimedia information from a central office to said subscriber premises, (2) subscriber order data from said subscriber premises to said central office location, and (3) telephone service signals between said subscriber premises and said central office;

switch means at said central office for receiving said subscriber order data from said subscriber loop transmission means;

a gateway responsive to said subscriber order data from said switch means for producing routing data;

a multimedia information file server means responsive to requests received from said video gateway for obtaining selected digital multimedia information from said digital information storage medium; and

a digital cross-connect switch responsive to said routing data for transferring said digital multimedia information from said multimedia information file server means to said subscriber loop transmission means.

16. The network of claim 15, wherein said multimedia information server means comprises:

subscriber request processing means responsive to subscriber request data for supplying information request data;

session control means responsive to said information request data for supplying information retrieval data and output control data;

data storage means responsive to said information retrieval data for supplying program data; and

output control means responsive to said output control data for supplying said multimedia information.

17. The network of claim 16, wherein said data storage means includes a plurality of storage media for storing said program data.

18. The network according to claim 17, wherein said data storage means includes optical storage means and magnetic storage means.

19. The network according to claim 18, wherein said data storage means includes different storage media having different respective information retrieval times.

20. The network according to claim 1, wherein said multimedia information server means comprises a data base.

21. The network according to claim 20, wherein said multimedia information server means comprises a plurality of data bases.

22. The network according to claim 21, wherein said plurality of data bases are distributed among plural sites.

23. The network according to claim 22, wherein said data bases are interconnected through said gateway.

24. The network according to claim 22, wherein said data bases are interconnected outside said gateway.

25. The network according to claim 1, including means for establishing a communication path between subscriber loops so as to enable multimedia information supplied by said provider to be shared by subscribers interactively.

26. The network according to claim 15, wherein said multimedia information server means comprises a data base.

27. The network according to claim 26, wherein said

multimedia information server means comprises a plurality of data bases.

28. The network according to claim 27, wherein said plurality of data bases are distributed among plural sites.

29. The network according to claim 28, wherein said data bases are interconnected through said gateway.

30. The network according to claim 28, wherein said data bases are interconnected outside said gateway.

31. The network according to claim 15, including means for establishing a communication path between subscriber loops so as to enable multimedia information supplied by said provider to be shared by subscribers interactively.

32. A public switched telephone network for providing information from a multimedia information server to any one of a plurality of subscriber premises, comprising:

a telephone company central office receiving multimedia information signals from a multimedia information server and subscriber orders from a prescribed subscriber, said central office including a video gateway for providing routing data in response to subscriber orders and a switch for routing multimedia signals from said server to the prescribed subscriber in accordance with said routing data;

a central office interface for transmitting or receiving audio telephone service signals, subscriber control signals and digital multimedia information signals on, respectively, first, second and third signal channels;

each said subscriber premises including a subscriber interface for transmitting or receiving audio telephone service signals, subscriber control signals and digital multimedia information signals on, respectively, the first, second and third signal channels; and

a plurality of subscriber local loops interconnecting corresponding subscriber and central office interfaces.

33. network according to claim 32, wherein said multimedia information server means comprises a data base.

34. The network according to claim 32, wherein said multimedia information server means comprises a plurality of data bases.

35. The network according to claim 34, wherein said plurality of data bases are distributed among plural sites.

36. The network according to claim 35, wherein said data bases are interconnected through said gateway.

37. The network according to claim 35, wherein said data bases are interconnected outside said gateway.

38. The network according to claim 32, including means for establishing a communication path between subscriber loops so as to enable multimedia information supplied by said provider to be shared by subscribers interactively.

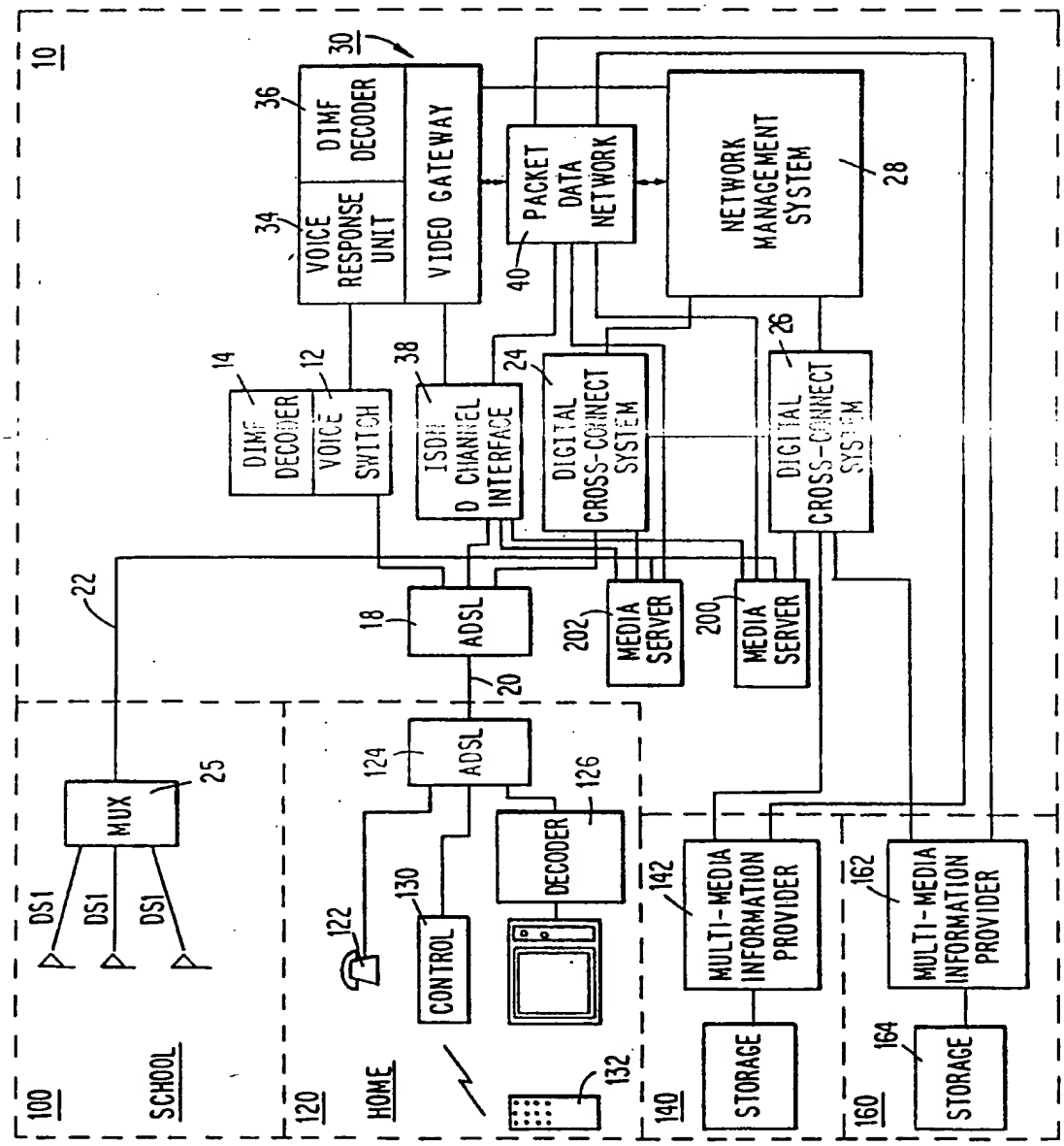
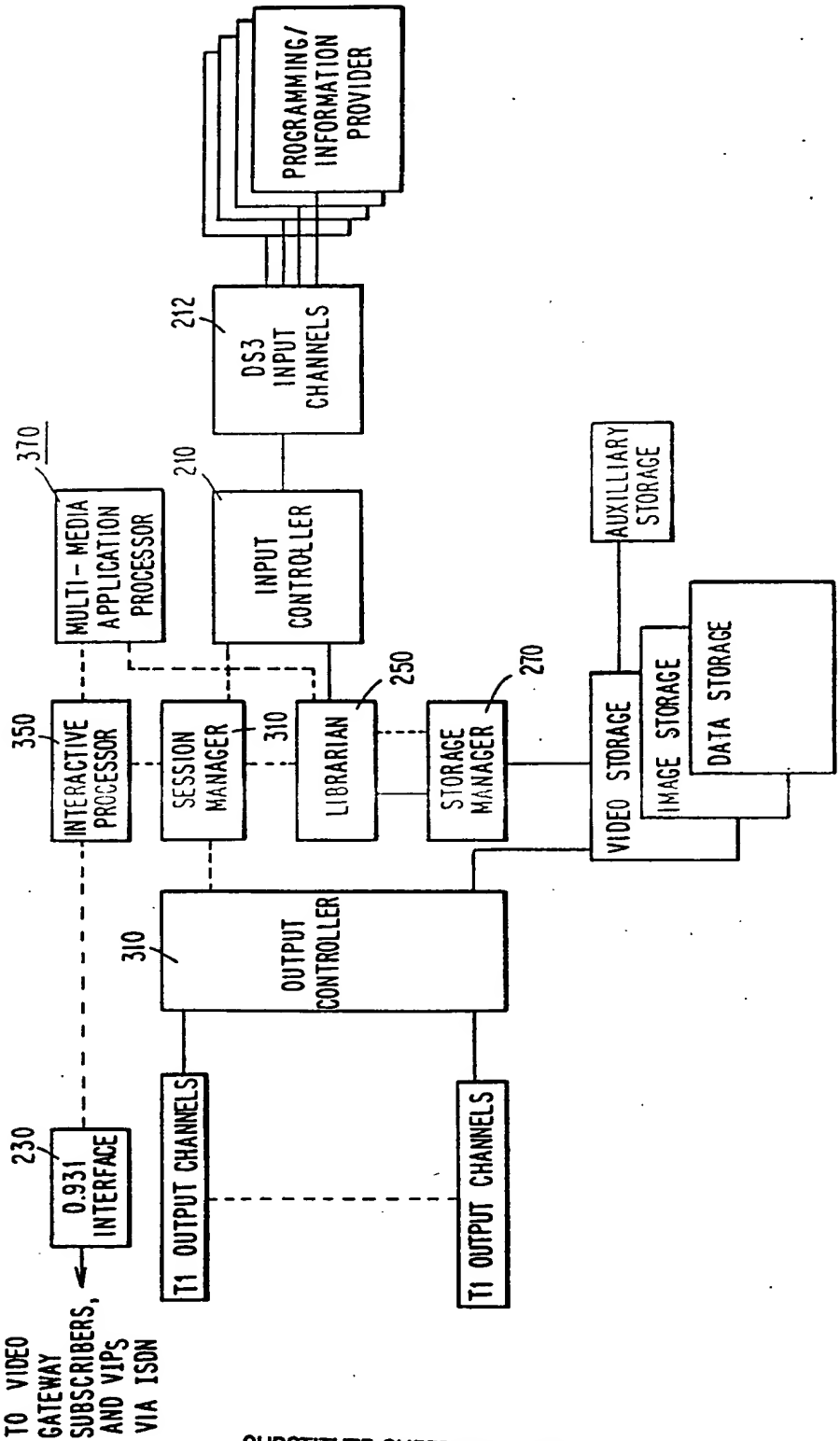

10
30
36
DIMF DECODER
34
VOICE RESPONSE UNIT
VIDEO GATEWAY
PACKET DATA NETWORK
NETWORK MANAGEMENT SYSTEM
28
40
14
12
38
24
26
DIMF DECODER
VOICE SWITCH
ISDN D CHANNEL INTERFACE
DIGITAL CROSS-CONNECT SYSTEM
DIGITAL CROSS-CONNECT SYSTEM
22
18
ADSL
202
MEDIA SERVER
200
MEDIA SERVER
20
124
ADSL
126
DECODER
25
MUX
DS1
DS1
DS1
122
130
CONTROL
142
MULTI-MEDIA INFORMATION PROVIDER
162
MULTI-MEDIA INFORMATION PROVIDER
STORAGE
164
STORAGE
132
100
SCHOOL
120
HOME
140
160

Figure 1

Figure 2


PROGRAMMING/ INFORMATION PROVIDER
212
DS3 INPUT CHANNELS
210
INPUT CONTROLLER
370
MULTI-MEDIA APPLICATION PROCESSOR
AUXILLIARY STORAGE
VIDEO STORAGE
IMAGE STORAGE
DATA STORAGE
350
INTERACTIVE PROCESSOR
SESSION MANAGER
310
LIBRARIAN
250
STORAGE MANAGER
270
310
OUTPUT CONTROLLER
230
0.931 INTERFACE
T1 OUTPUT CHANNELS
T1 OUTPUT CHANNELS
TO VIDEO GATEWAY SUBSCRIBERS, AND VIPs VIA ISDN

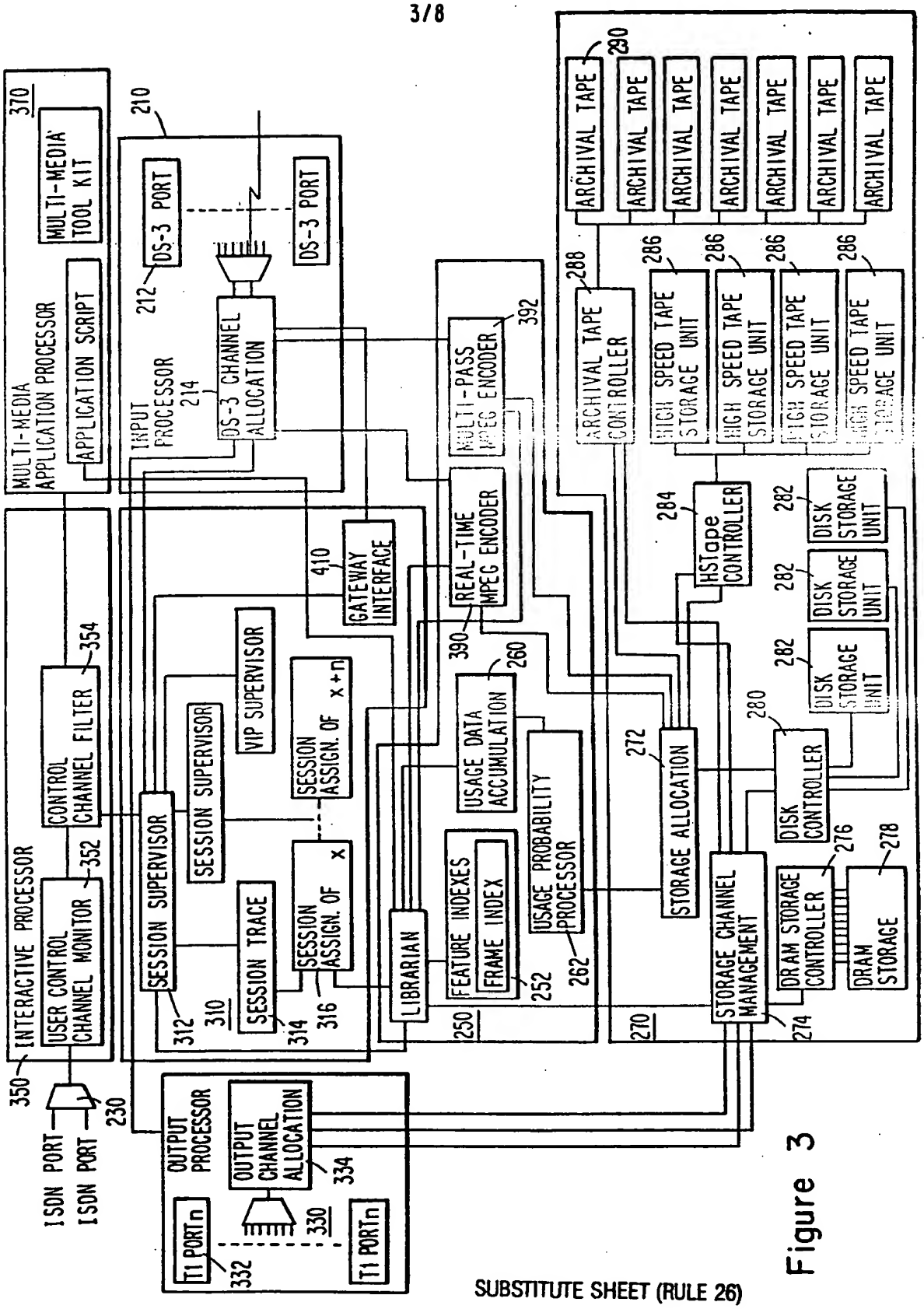

INTERACTIVE PROCESSOR
MULTI-MEDIA APPLICATION PROCESSOR
APPLICATION SCRIPT
MULTI-MEDIA TOOL KIT
INPUT PROCESSOR
DS-3 CHANNEL ALLOCATION
DS-3 PORT
DS-3 PORT
MULTI-PASS MPEG ENCODER
REAL-TIME MPEG ENCODER
GATEWAY INTERFACE
CONTROL CHANNEL FILTER
USER CONTROL CHANNEL MONITOR
SESSION SUPERVISOR
SESSION SUPERVISOR
VIP SUPERVISOR
SESSION TRACE
SESSION ASSIGN. OF x
SESSION ASSIGN. OF x+n
LIBRARIAN
FEATURE INDEXES
FRAME INDEX
USAGE DATA ACCUMULATION
USAGE PROBABILITY PROCESSOR
STORAGE ALLOCATION
STORAGE CHANNEL MANAGEMENT
DISK CONTROLLER
DRAM STORAGE CONTROLLER
DRAM STORAGE
HSTape CONTROLLER
ARCHIVAL TAPE CONTROLLER
HIGH SPEED TAPE STORAGE UNIT
ARCHIVAL TAPE
DISK STORAGE UNIT
ISDN PORT
ISDN PORT
OUTPUT PROCESSOR
OUTPUT CHANNEL ALLOCATION
T1 PORTn
T1 PORTn
350
230
354
352
370
210
212
214
410
392
390
260
252
262
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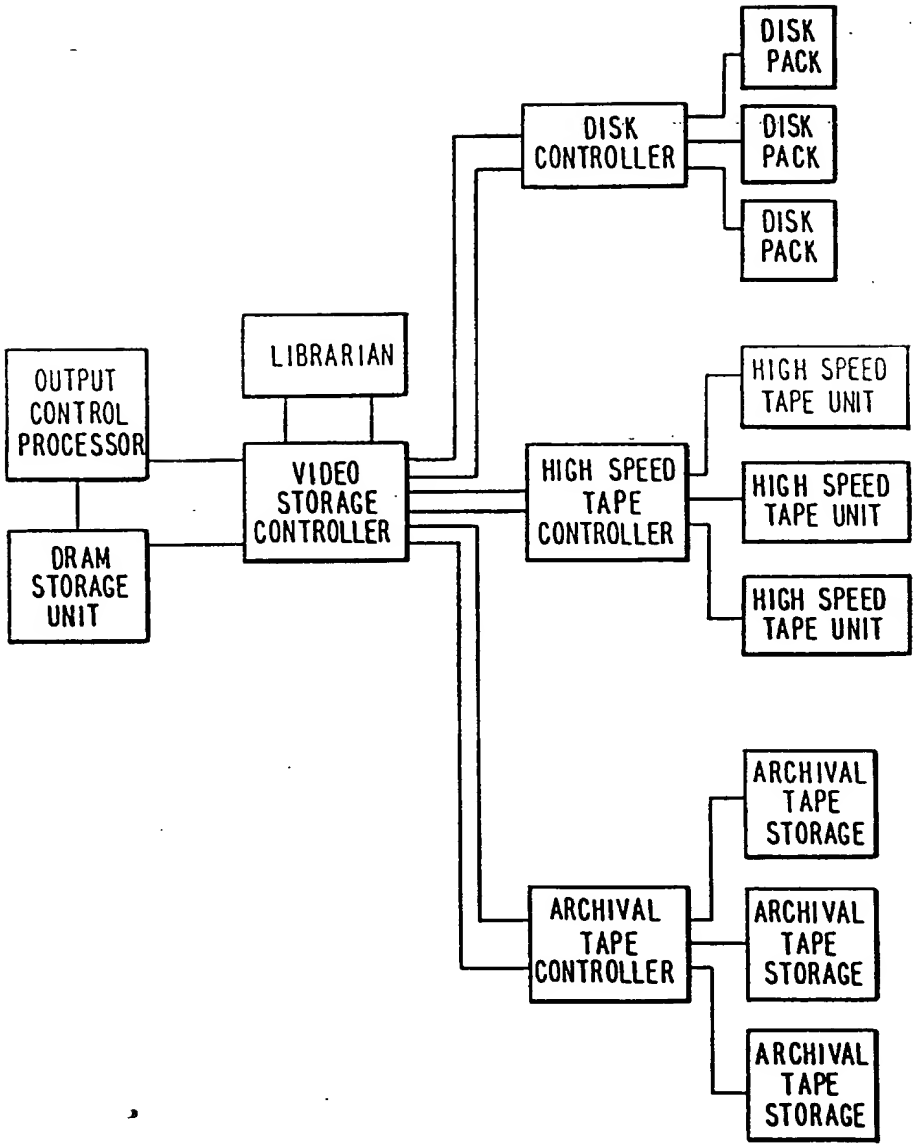
Figure 3


DISK PACK
DISK PACK
DISK PACK
DISK CONTROLLER
LIBRARIAN
OUTPUT CONTROL PROCESSOR
VIDEO STORAGE CONTROLLER
HIGH SPEED TAPE UNIT
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HIGH SPEED TAPE UNIT
HIGH SPEED TAPE CONTROLLER
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ARCHIVAL TAPE STORAGE
ARCHIVAL TAPE CONTROLLER

Figure 4

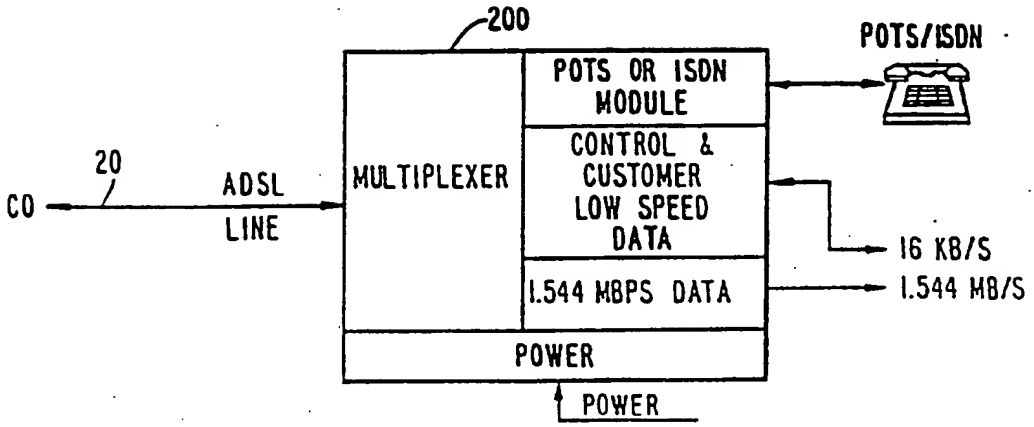

Figure 5

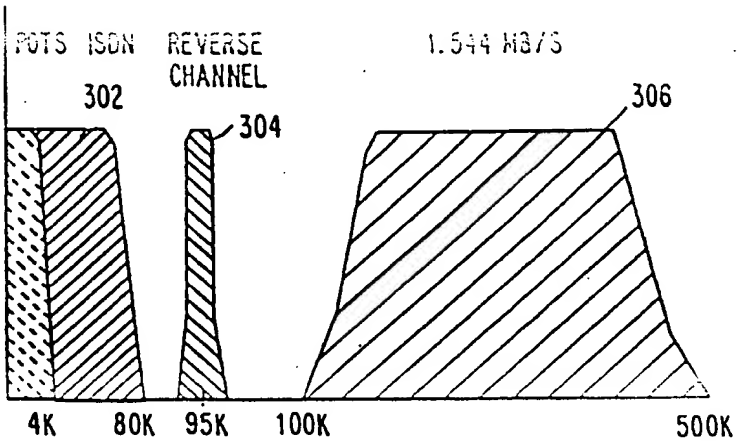

Figure 6

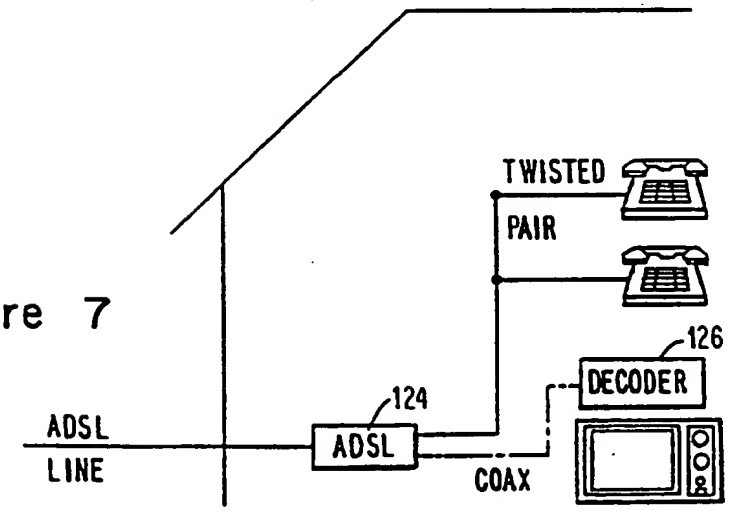

Figure 7

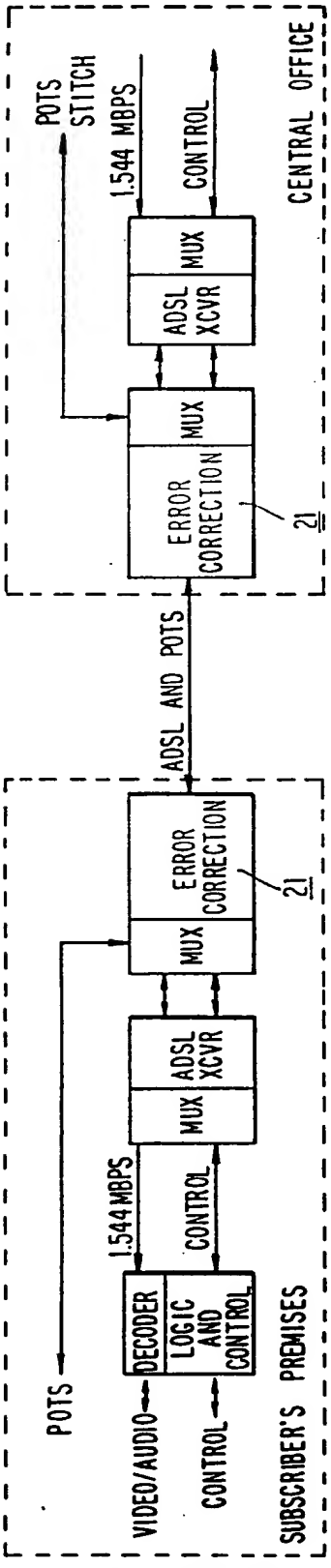
CENTRAL OFFICE
POTS STITCH
1.544 MBPS
CONTROL
MUX
ADSL XCVR
MUX
ERROR CORRECTION
21
ADSL AND POTS
SUBSCRIBER'S PREMISES
ERROR CORRECTION
21
MUX
MUX
ADSL XCVR
1.544 MBPS
CONTROL
DECODER
LOGIC AND CONTROL
POTS
VIDEO/AUDIO
CONTROL

Figure 8

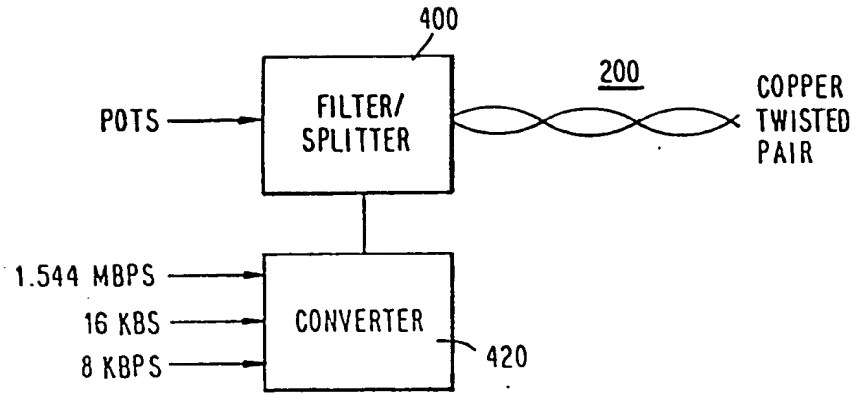

Figure 9

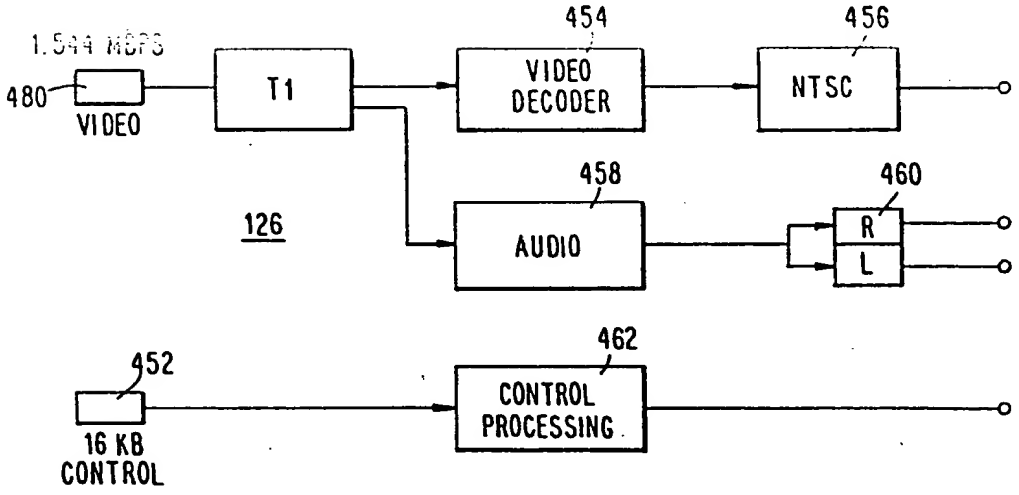

Figure 10

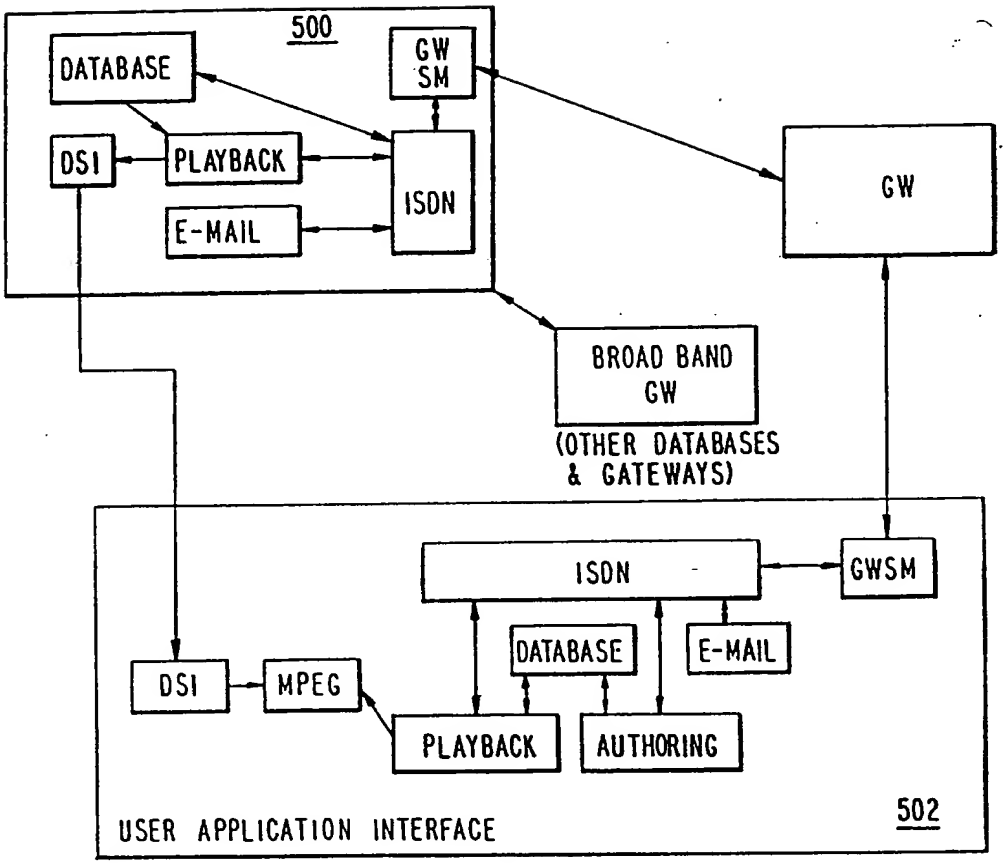

Figure 11

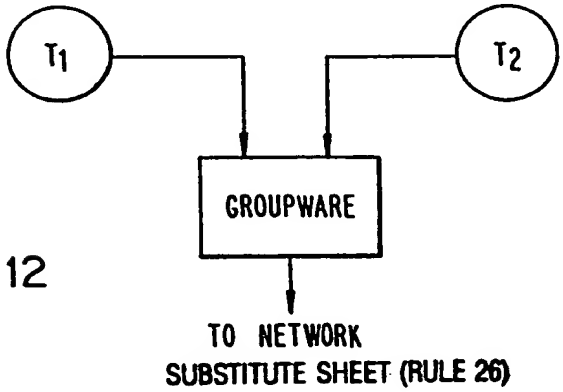

Figure 12

INTERNATIONAL SEARCH REPORT

Internatior pplication No
PCT/US 94/03629

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 H04N7/173 H04N7/15

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 5 H04N H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US,A,5 130 792 (TINDELL ET AL.) 14 July 1992	1,15,32
A	see the whole document	2-14, 16-31, 33-38

Y	IEEE COMMUNICATIONS MAGAZINE, vol.30, no.7, July 1992, NEW YORK, US pages 36 - 41 SUTHERLAND ET AL. 'RESIDENTIAL VIDEO SERVICES'	1,15,32
A	see the whole document	2-14, 16-31, 33-38

A	WO,A,92 12599 (YURT ET AL.) 23 July 1992 see the whole document	1-38

	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 August 1994	12.09.94

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+ 31-70) 340-3016	Greve, M

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US 94/03629

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US,A,4 949 187 (COHEN ET AL.) 14 August 1990 see column 3, line 62 - column 5, line 17	1-38
A	GB,A,2 207 838 (TELACTION CORP.) 8 February 1989 see the whole document	1-38
A	US,A,4 847 829 (TOMPKINS ET AL.) 11 July 1989 see the whole document	1,15,25, 31,32,38

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Internatior. .pplication No
PCT/US 94/03629

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A-5130792	14-07-92	EP-A-	0562186	29-09-93
WO-A-9212599	23-07-92	US-A-	5132992	21-07-92
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		EP-A-	0566662	27-10-93
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